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ORIGINAL PAPER

The common information platform for natural hazards in Switzerland

Benedikt Heil · Ingo Petzold · Hans Romang · Josef Hess

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Abstract With the increasing frequency of hydrological hazard events during the last years, also the problem of combined rain and snow melt hazards has increased. A series of remarkable hazardous events in Switzerland, particularly the severe flood in August 2005, triggered a cooperation between the official Swiss warning centres for individual natural hazards. This cooperation became increasingly supported and was pushed politically. A main outcome was a joint project to launch the so-called Common Information Platform for Natural Hazards GIN (“Gemeinsame Informationsplattform Naturgefahren”). The objective was to achieve a system to allow a combined and user-friendly visualisation of safety relevant data in real time along with granting access to substantial information provided by the warning centres. A further goal was to strengthen the collaboration between the Swiss warning centres, particularly by the provision of joint bulletins in critical multi-causal events. In this way, GIN will become the central information hub for natural hazard events in Switzerland. A first user satisfaction evaluation of the web-based information platform revealed positive results. This paper focuses on the description of GIN and discusses the development work behind it.

Keywords Risk management · Decision support · Real-time information system · Interactive visualisation platform · Spatial information services

B. Heil (✉) · I. Petzold
WSL Institute for Snow and Avalanche Research SLF, Flueelastrasse 11, 7260 Davos, Switzerland
e-mail: heil@slf.ch

H. Romang
Federal Office of Meteorology and Climatology MeteoSwiss, Kraehbuehlstrasse 58, 8044 Zurich, Switzerland

J. Hess
LAINAT, Federal Office for the Environment FOEN, Worblentalstrasse 68, 3063 Ittigen, Switzerland

1 Introduction

Climate change may not only increase the frequency but also the intensity of natural hazards. McBean (2004) states that the projected warmer and wetter atmospheres in mid-latitudes are expected to cause more extreme hydro-meteorological hazards. This is supported by research concerning impacts of climate change on natural hazards in Central Europe. First, Haines et al. (2006) and Lehner et al. (2006) expect flash floods to increasingly occur. Second, the frequency of rock falls is likely to increase due to warmer temperatures and melting permafrost (Gruber et al. 2004). Third, changes in the snowpack may increase the chance of snow avalanches (Martin et al. 2001; Haeberli and Burn 2002). Furthermore, IPCC (2007) expects Central Europe to suffer from more droughts and heat waves in the future. It is however not yet conclusively determined that natural hazards are already occurring more often or more intense as a result of climate change (Bärring and Persson 2006; Schwierz et al. 2010).

Nevertheless, the Swiss government decided to enhance cooperative warning and mitigation strategies. In particular, one focus was put on dealing with multi-causal natural hazards. For example, hydrological hazards like floods are not only caused by heavy rainfall. Especially in spring, melting snow in the mountains may also have a critical impact. Warm but rainy weather in spring can cause disastrous floods in the relatively flat Central Plateau, the most densely populated area in Switzerland. This was shown dramatically in two flood events from the years 1999 and 2005 (Aschwanden 2000; UVEK 2008).

Today, three governmental organisations are responsible for issuing warnings in Switzerland: the Federal Office of the Environment FOEN (floods), the Federal Office for Meteorology and Climatology MeteoSwiss (weather-related hazards such as storms) and the WSL Institute for Snow and Avalanche Research SLF (avalanches). These warning centres operate separate warning and information platforms for the specific hazards they are responsible for. Thus, during combined hazardous events, risk managers have to use these different systems in order to receive the necessary information.

In case of a hazard event, information on environmental conditions and forecasts should be accessible in a quick and simple way. Web-based platforms allow access to a large audience and can support decision-making during a disastrous event. Therefore, the GIN project was started in 2008. GIN is a German acronym meaning “Common Information Platform for Natural Hazards” (Gemeinsame Informationsplattform Naturgefahren).

GIN is intended for providing substantial information to cope with hazard events on one central platform. This is essentially achieved by making available measurement data and predictions in real time. The three warning centres provide their already established data products for individual hazards and will develop new joint information to allow for managing multi-hazard events.

Because GIN holds critical data that is not trivial to interpret correctly, access to the platform is restricted to federal, cantonal or municipal intervention forces. The users of GIN are therefore regarded as specialists in hazard mitigation. However, due to the fact that the users are considered to be differently familiar to web services, the information should be presented in a user-friendly way. In order to achieve this goal, the user-centred design process for interactive systems (ISO 1999) was applied (see Sect. 3). Moreover, data visualisation should not differ between different data providers such as the Swiss warning centres, but should support a combined evaluation by natural hazard experts and civil protection services. Finally, GIN supports joint warnings of the three official warning centres in case of multi-hazard events.

2 Data and content of GIN

GIN is designed to present a large variety of data and to visualise it in different ways. It handles both, measured and predicted data. Numerical data can be depicted as labelling of measuring station symbols on the map, as plot in diagrams as well as in tables. The map can be overlaid with raster data, such as precipitation radar images. It is also possible to present text information in the form of bulletins and warning messages.

Due to the use of generic data structures to represent arbitrary data sources and its mapping to a relational database, data sources can be easily integrated into GIN. Currently, GIN contains approximately 80 measurement parameters from more than 500 data sources, such as measuring stations or bulletins. At the moment, data is delivered by the three official warning centres only. In the near future, however, data from further organisations will be added.

The diversity of data providers requires a standardised interface for data delivery. Therefore, appropriate XML schemata were designed. One schema allows a homogenous description of data sources. This description, also called metadata, contains the name of the data source, its geographical location, the measured parameters and information about the data provider. A further XML schema is used for exchanging data. Raster data can be delivered in common binary formats, such as geo-referenced GIF or PNG. To sum up, in spite of the variety of data, GIN enables to visualise information from different sources in a homogeneous way by defining standards for data exchange.

3 The development process

To develop a usable and satisfying system, a human-centred design process was pursued. The International Organisation for Standardisation (ISO) has defined a process for human-centred design for interactive systems (ISO 1999, see Fig. 1). Because ISO works with a broad base of stakeholders and creates standards on the basis of input from a large number of experts (ISO 2008), its norms are widely accepted.

ISO 13407 defines four user-centred design activities during the development of interactive systems: (1) understand and specify the context of use, (2) specify the user and organisational requirements, (3) produce design solutions and (4) evaluate designs against requirements. In addition, the process supports iteration loops, which are crucial to develop a usable and widely accepted information platform.

The overall background of the GIN project has been explained above. In order to get detailed knowledge about the context of use, a support group, consisting of specialists in the natural hazard domain, was founded to attend the project. Points (2) to (4) are discussed in the following sections.

3.1 User and organisational requirements

From a user perspective, it was crucial to develop an easy to use and intuitively understandable tool. One of the challenges was to satisfy heterogeneous user groups. As explained in Sect. 1, users of GIN are likely to differ in their skills to use web-based information platforms.

The organisational requirements were strongly influenced by existing systems, operated by the three official warning centres, which GIN is intended to replace in the near future. These web-based tools present identical or similar data to those presented on GIN but in

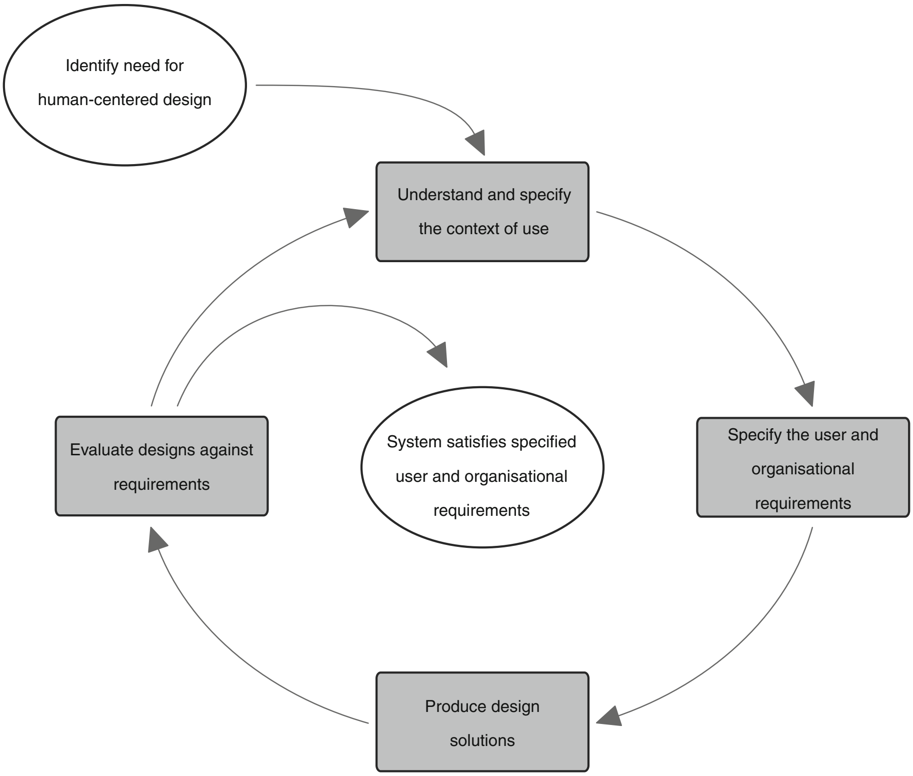

Fig. 1 The ISO 13407 human-centred design lifecycle model (adapted from ISO 1999)

diverse manners with differing user interfaces. The three systems with major impact to the organisational requirements are introduced shortly in the following paragraphs.

Today, SLF operates the Intercantonal Early Warning and Crisis Information System IFKIS (Bründl et al. 2004), which is used for avalanche warning. IFKIS provides access to measurements of snow and wind stations in Switzerland and to data from forecasting models. This data is visualised in tables and diagrams for each station. Additional information such as maps on avalanche risk or on current snow heights is available. For small-scaled hydrological hazards, IFKIS has been extended to IFKIS-Hydro (Romang et al. 2010).

Meteorological and hydrological warnings and predictions are presented in a tool, called MAP D-PHASE (demonstration of probabilistic hydrological and atmospheric simulation of flood events in the alpine region), operated by MeteoSwiss. This system is based on high-resolution atmospheric forecast models and provides decision support for risk managers. It is a map-based tool, which warns against heavy precipitation events (Arpagaus et al. 2009).

4 System and graphical user interface

The graphical user interface (GUI) of GIN is basically divided into six parts (see Fig. 2). The navigation menu (1) is situated on the left-hand side. It is divided into several

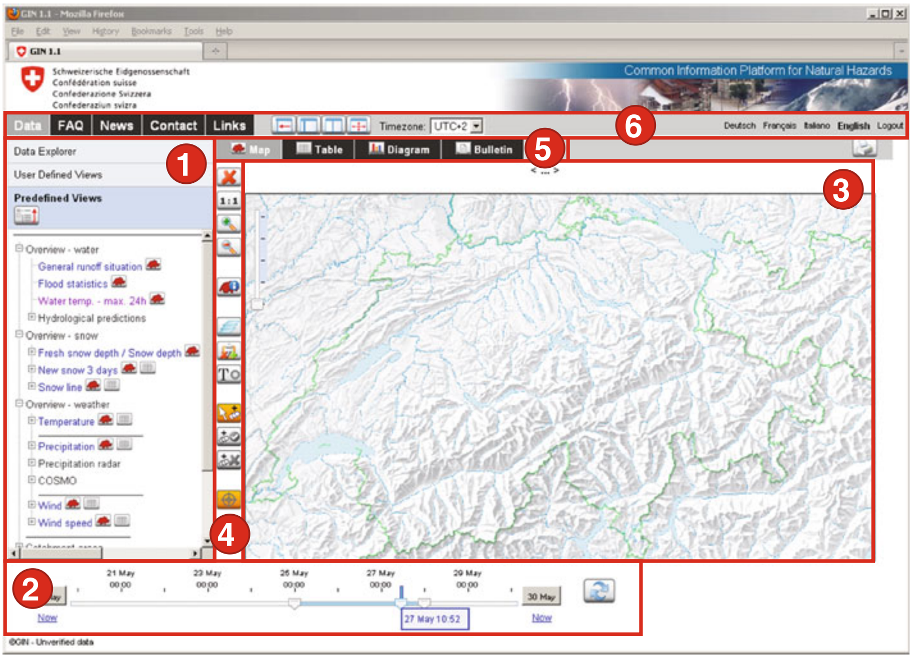

Fig. 2 Screenshot of GIN's map interface. The six main parts are highlighted in red: (1) navigation menu, (2) time slider, (3) data visualisation area, (4) toolbar, (5) visualisation mode selection and (6) further information and settings

accordion menus. In the lower part of the interface, a time slider (2) allows the selection of the desired time period. The biggest area of the screen is used for data visualisation (3). As a consequence maps, tables, diagrams and text information can be displayed. On the left-hand side of the visualisation area, a toolbar (4) supports interaction. The look of the toolbar and its functions depend on the visualisation mode, i.e. map, table, diagram and bulletin. The tabs (5) above the visualisation window sort the different visualisation modes. A further tabs-section (6) on top of the interface is used to provide access to additional information and allows setting general preferences. In the following sections, the interface and the functions of GIN are explained in detail.

4.1 Architecture overview

GIN is a web application and consists of five components (see Fig. 3). These components share the same program code and interact with each other, but run independently. The data transfer component is responsible for the import of data and is written in Java. Data is stored in a relational database, using spatial data types to store locations of the data sources together with information about visualisation, configuration and user management. An Oracle database is used. The GUI is enabled by the web-application component and displayed by a web-browser. The client side of GIN is based on JavaScript to enable high interactivity and fast response times. The JavaScript code on the client side is mainly developed internally. For the map visualisation and its interactivity, however, ArcGIS Web Mapping APIs (ESRI 2010) are utilised. The background map and the map layers are provided by a web map server (WMS) in tiles for five fixed scales. On the server side, Java

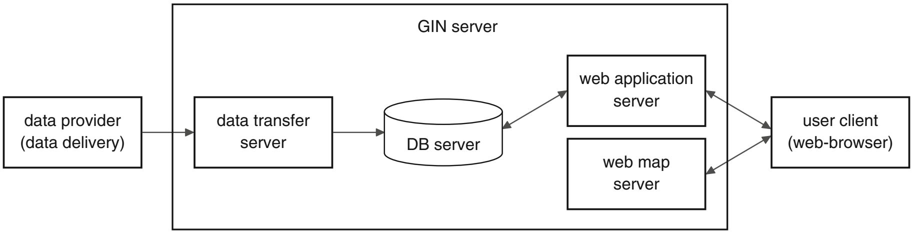

Fig. 3 The system architecture of GIN. Data providers send data to the GIN data transfer server (FTP). After a quality check, data is stored in a database, which is accessed by the web application

is used to provide the clients with data and to generate diagrams on demand. During the development, we focused on accomplishing fast response time for the user, flexibility, scalability of the system and thus performance, system-stability and utilisation of existing and suitable libraries. Mainly standard Java libraries like iBATIS (iBATIS 2010), XML-Beans (Apache Software Foundation 2010) and Spring (SpringSource 2010) as well as JavaScript libraries like dojo (The Dojo Foundation 2010) and Prototype (Prototype Core Team 2010) are used.

4.2 Navigation

GIN holds an enormous amount of data. More than 500 data sources with around 80 parameters need to be presented and combined in the navigation. Consequently, it was crucial to design a detailed but still usable navigation menu. The navigation part on the left-hand side of the interface is therefore split into three parts. A menu divides it into data explorer, user-defined views and predefined views. Figure 4 depicts the different sections of the navigation in GIN.

The data explorer on the left-hand side of Fig. 4 allows users to navigate through all available data. Therein, two different ways exist to navigate through the desired data: (1) the parameters list: topic-related hierarchical structure and (2) the data sources/stations list: data source-related hierarchical structure, sorted by data provider. For example, if the user is interested in the current runoff in rivers in Switzerland, the following navigation paths are possible: (1) Parameters—Water—Runoff Measured—Rivers and Lakes; (2) Data source—FOEN—Rivers and Lakes.

User-defined views (second column in Fig. 4) cannot yet be interactively defined by users. This is currently accomplished by an administrator. The interactivity will be developed and available from next year on.

The predefined views section (third column in Fig. 4), however, is the most important textual navigation menu. Predefined views are outputs with a focus on maps, prepared by an administrator for easy and fast access. They are created according to requests from users and the Swiss warning centres.

4.3 Time selection

The time selection can be performed using sliders on a time line at the bottom of the interface (see Fig. 5). Three sliders provide the possibility to adjust the time for all different kinds of visualisations. The single time slider in the middle is used to set the map time. The outer two sliders define the time interval for tables and diagrams. Furthermore, it

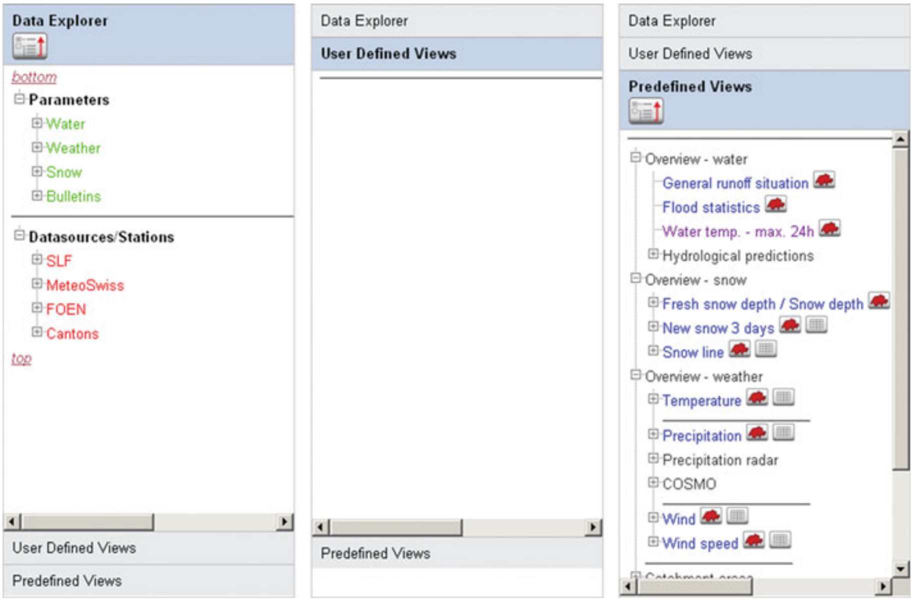

Fig. 4 The three different navigation menus in GIN (composed of three screenshots): data explorer, user-defined views and predefined views. The width of the navigation part can be increased using the dedicated buttons in the settings bar (Nr. 6 in Fig. 2)

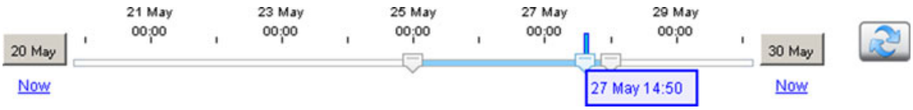

Fig. 5 Screenshot of the time slider in GIN

has been considered during the development, that the default placement of the time sliders is always set to the current time after the login. The current time is indicated by a brightly coloured blue line. If adjustments in time were made, a mouse click on this identifier sets the slider automatically back to the current time. After moving the time slider, the user has to accept the choice by clicking on the refresh button, situated to the right of the time slider. After clicking the refresh button, a request to the server is sent in order to get the desired data at the selected time. In addition to the sliders, the grey buttons at the end of the time line provide functionality to select dates on a calendar-like dialogue.

4.4 Visualisation

GIN supports four kinds of visualisations: maps, tables, diagrams and bulletins. For these visualisations, arbitrary combination of data sources and parameters is supported.

In all tables (see Fig. 6), the number of parameters is restricted to 12 due to readability constraints. Otherwise, an overview table enables to interactively reduce the number of displayed parameters.

A single diagram is restricted by a maximum of two different units (see Fig. 7). In order to enable a detailed data analysis, a mouse-over event evokes a reference line to one point

	Luzern		
Date & Time	Temperature °C	Gust peak km/h	Wind speed 10min km/h
27 05 2010 - 14:50	18.2	17	9
27 05 2010 - 14:40	18.6	14	7
27 05 2010 - 14:30	17.9	12	6
27 05 2010 - 14:20	16.8	15	7
27 05 2010 - 14:10	16.4	15	8
27 05 2010 - 14:00	16.1	10	5
27 05 2010 - 13:50	15.6	15	7
27 05 2010 - 13:40	15.4	13	7
27 05 2010 - 13:30	15.8	13	3
27 05 2010 - 13:20	16.2	7	3
27 05 2010 - 13:10	15.7	15	4
27 05 2010 - 13:00	15.4	12	4
27 05 2010 - 12:50	15.6	5	1

Fig. 6 Screenshot of a table generated in GIN, showing wind speed (10 min mean value), gust peak (one-second maximum value) and temperature (measured 2 m above ground) at one specific station

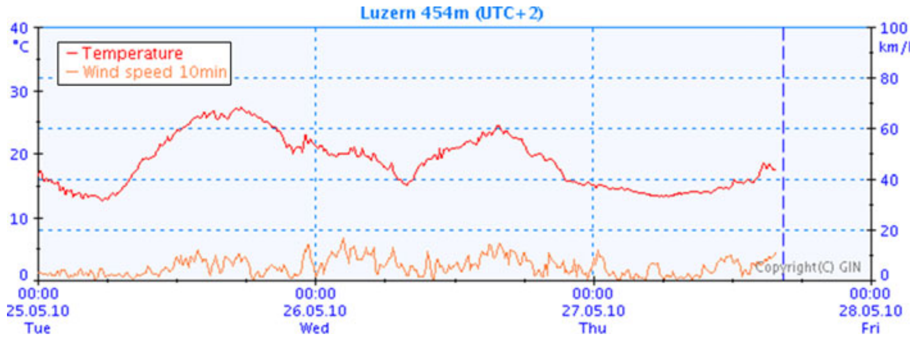

Fig. 7 Screenshot of a diagram showing measurement values for wind speed and air temperature, generated in GIN

of time in the diagram. By moving the mouse pointer over the diagram, the reference line moves simultaneously and a pop-up legend displays the exact numerical values at this line.

The map visualisation in GIN allows zooming and panning. Maps are also used to interactively navigate through data. The background map in GIN is a relief of Switzerland. The monotonic colours in this map allow using a larger colour space to overlay various information. Users can also add static layers containing rivers, catchment areas, political

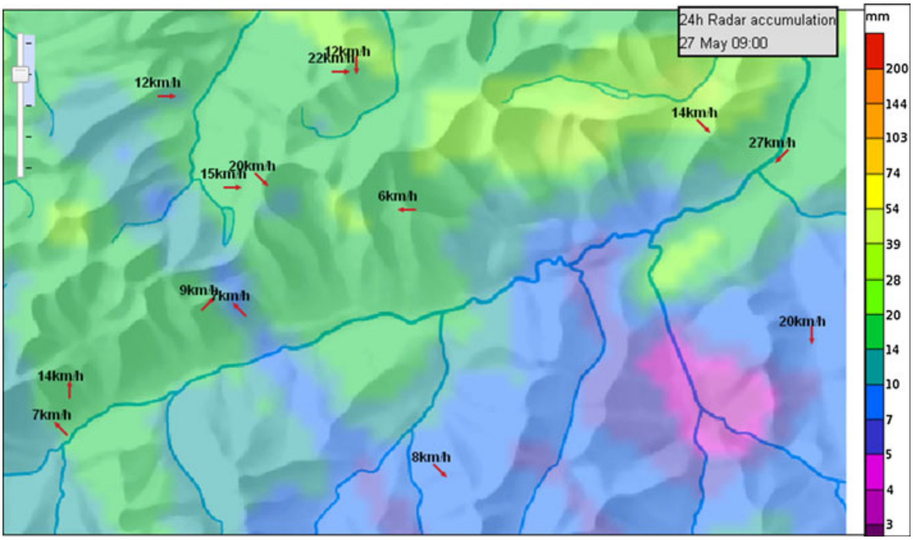

Fig. 8 Screenshot of a map generated in GIN, showing the relief and the river layer, overlapped with information about wind speed, wind direction, gust peak and precipitation radar data

borders and major towns. Users can change transparency of these layers according to their request. An example of a map is depicted in Fig. 8.

Data sources of any geometry (point, line and polygon) can be displayed on the map. The shapes and styles of the associated point, line and polygon symbols are defined by the moderator of GIN. The size and colour of shapes are usually dependent on values of the associated data source. Instead of primitive symbols also images or icons can be used, still with the possibility to resize them depending on a specific parameter value (see Fig. 9).

To allow users a quick reception of information, data sources can also be labelled. The labelling as well as the map visualisation is performed on the client side in the web-browser using JavaScript. The advantage compared to a web-map-server solution is the much higher interactivity and shorter reaction time.

Forecast data can be visualised in tables and diagrams (see Fig. 10). These diagrams are interactive, which allow for instance setting user-defined quantile ranges.

5 User satisfaction evaluation

A preliminary version of GIN was tested by approximately 100 users for around 5 months. The majority of the test users were employees of the organisations involved in the GIN project. Nevertheless, the remaining 40% of the test users were responsible for risk management in different municipalities. In general, the test users were considered to be future users of GIN. They were asked to give feedback about usability issues, inform the development team about requirements of further data and provide input for system enhancements. In order to obtain evaluable feedback, an online questionnaire with mostly closed questions was prepared. Twenty-two test users participated in the poll. The answers

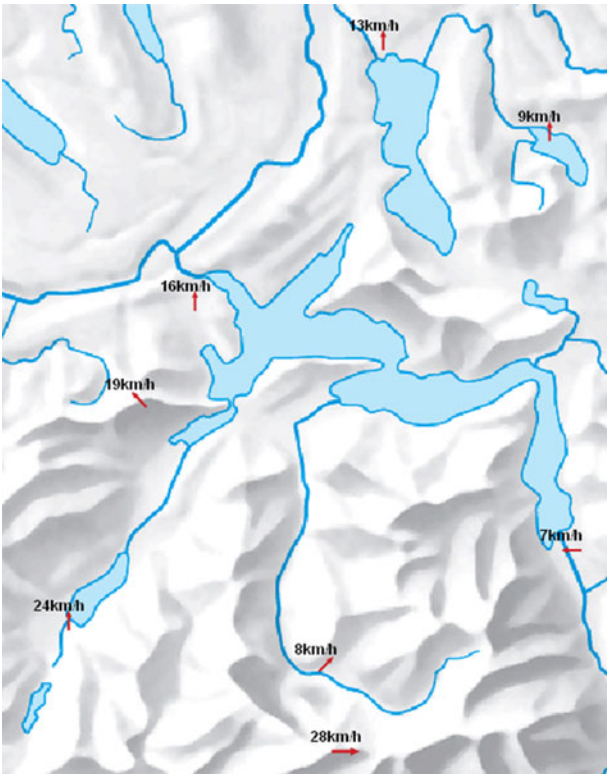

Fig. 9 Clipped screenshot of a map generated in GIN. Each *arrow* represents a measuring station. Its direction shows the wind direction, and the size specifies the wind speed. In addition, the gust peaks are labelled above each measuring station

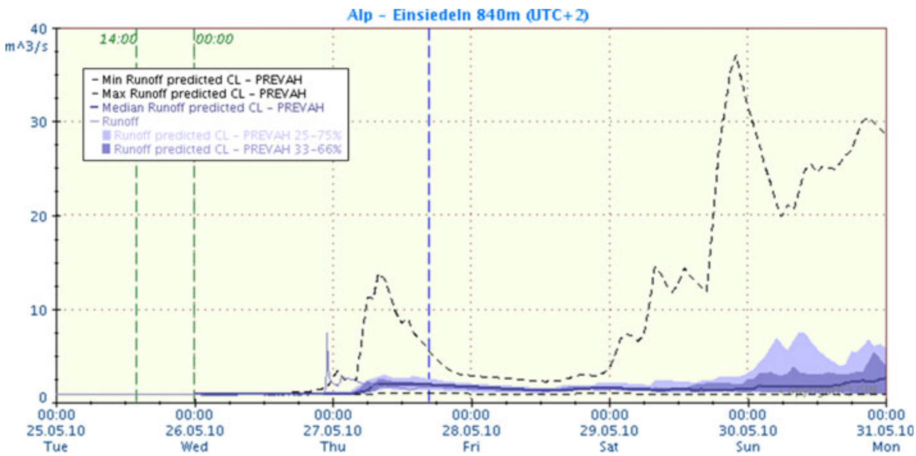

Fig. 10 Screenshot of a diagram showing prediction data generated in GIN for the Alp River measuring station in Einsiedeln. The blue line indicates the measured runoff. The *pink* area describes the quantile range of different runoff prediction model runs, whereas the purple line symbolises the median forecasted runoff at the measuring station. *Dashed lines* depict the maximum and minimum of the different model runs

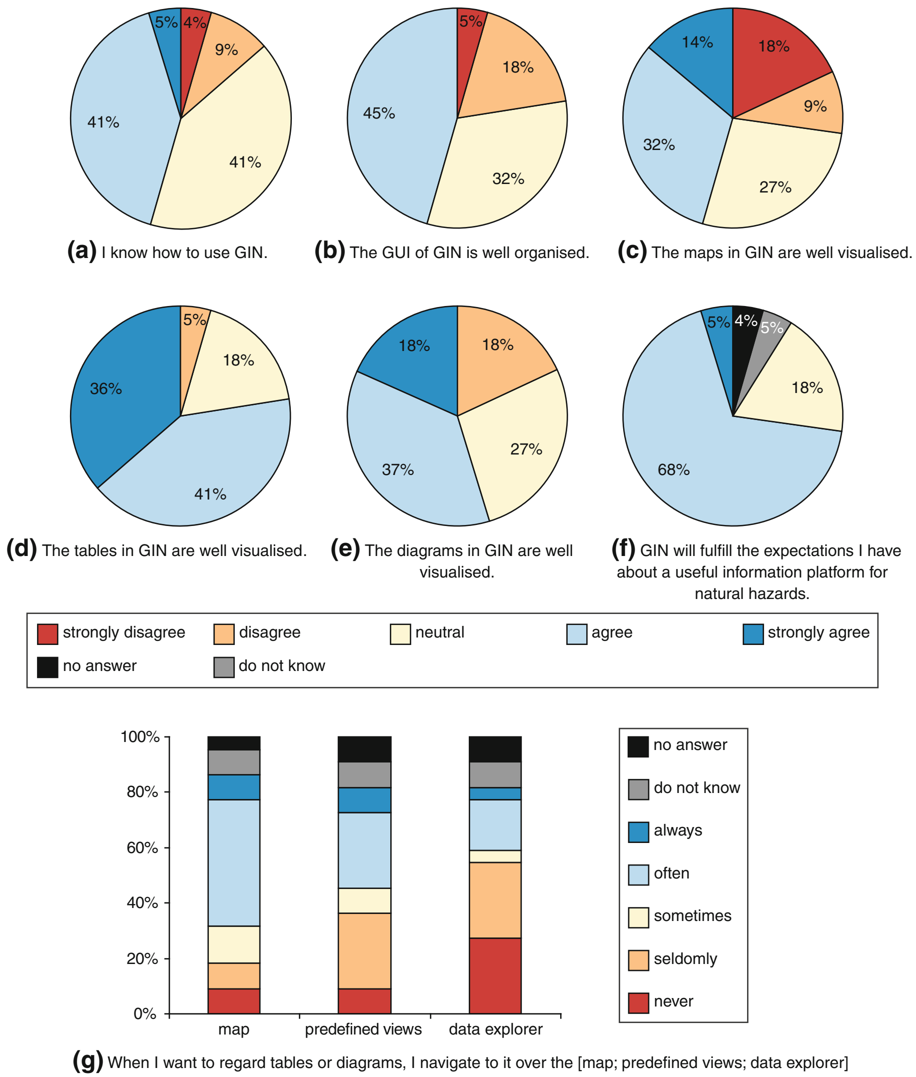

Fig. 11 Set of diagrams visualising some results of the user satisfaction survey. Response rate $n = 22$

were not analysed quantitatively because the response rate of 22 was considered to be too small. Nevertheless, the results of a qualitative analysis helped getting information about the users' satisfaction. Figure 11 depicts a selection of the most important results in the form of diagrams.

The general question about the users' system knowledge (Fig. 11a) was answered in a rather positive way. Answers about the comfort level with the GUI were intermediate (see Fig. 11b). Over two-thirds of the answers were positive or neutral. Nevertheless, no one claimed that the GUI is excellent. Four out of four voluntary comments about the GUI were negative statements on the complex navigation tree. As mentioned in Sect. 4.1, GIN will support user-defined views in the future, allowing to set personal quick links to preferred contents. The developers of GIN suppose that this functionality will solve the

Fig. 12 Clipped screenshot of a map in GIN, highlighting the label placement issue

problem of the extensive tree navigation. The statements about the maps in GIN diverged (see Fig. 11c). Although almost half of the participants rated the maps in a positive way, over a fourth of the users thought the maps were bad or very bad. Five out of six comments about the maps were negative statements on the insufficient label placement (see Fig. 12). Achieving a suitable labelling is a computationally intensive process and thus not feasible to do it in real-time web mapping (Petzold et al. 2003; Marks and Shieber 1991). However, a pragmatic solution was found to avoid overlapping by only displaying labels if a defined zoom level is reached.

The tables however (see Fig. 11d) were rated very well. Over three-fourth of the participants appraised them positively. The results of the question about the diagrams were rather positive too (see Fig. 11e). Approximately half of the users found them to be good or excellent, whereas about a fourth rated them neutral. Figure 11f depicts the results of a very relevant question. The purpose of the question was to find out whether the developers of GIN were on a good way to fulfil the users' expectations about an information system for natural hazards. The answers to these questions were mainly positive. Indeed, no negative answer was given. The results of another crucial question are depicted in Fig. 11g. The idea behind this question was to find the way how the test users navigate through the desired data. Three navigation-possibilities exist: (1) the map, (2) the predefined views or (3) the data explorer. According to the results, the respondents clearly preferred the map.

To conclude, the user interface of GIN has been rated as sufficient. The survey helped the developers to identify and prioritise needs for further development. An extract of enhancements and new features is given in Table 1.

Moreover, the project leaders gained knowledge about user satisfaction. It was revealed that the project is on the right track.

Table 1 Examples of further needs for development, evolved from the results of the user satisfaction survey

Component	Enhancement
Map	Resolve label overlapping issue
	Add mouse-over information to stations and other map features
	Increase transparency of base map to reduce its dominance
Diagram	Enlarge diagrams
	Define clearer colours in order to enhance determination of plot lines
	Avoid the need to scroll horizontally
GUI	Enhance tab visualisation
	Delete unnecessary GUI components
	Provide two GUIs: a simple mode besides the expert mode

6 Conclusion and outlook

GIN is a reaction to the catastrophic flooding in August 2005, but also should anticipate expected increase of frequency and severity of natural hazards in view of the climate change. The project will help to intensify the collaboration between the individual warning centres especially in coping with combined natural hazards. GIN is not only a milestone of cooperation between the involved warning centres but also for the intervention forces. Now, they can access basic information from various sources via one platform, which is quick and easy to use. The homogenous and moderated visualisation simplifies their work and supports their decision-making. To achieve these objectives, a large commitment of all cooperation partners and also of the users was and is still needed. A questionnaire among potential users revealed a demand for user-defined views, which will be one of the next extensions in GIN. User-defined views will be defined interactively by the users.

The need for coordinated bulletins to support action forces during multi-hazard events has been identified. One of the most crucial problems is the fact that currently, the three official Swiss warning centres use different warning regions, which will have to be harmonised as far as possible. Related to that, consistent warning levels and thresholds for important parameters are already defined.

Moreover, homogenous colourisation and visualisation is particularly eminent for untrained users. E.g. radar images visualising the measured precipitation should use the same colour table as predicted precipitation, which is also visualised by a raster image.

Further extensions in the near future will be map-based visualisation of automatic warnings depending on predictions and warning levels as well as integration of data from the Swiss Seismological Service. It is also planned to develop a public version of GIN with reduced complexity and data mining possibilities. GIN will also be integrated into the reporting systems of the National Emergency Operations Centre. It is obvious that the development of GIN is not finished when going into official operation. Further development is necessary, and the cooperation between the warning centres must be further strengthened.

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